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6. AUTHOR(S)

Bengt O. Muthen

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

University of California, Los Angeles

405 Hilgard Ave.

Los Angeles, CA 09924-1521

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Summary of research and references to papers

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Recent theoretical developments in the areas of latent variable modeling and missing data theory provide the basis for new psychometric analyses of the relationship between job performance and test performance. New approaches to the assessment of predictive validity of tests as well as to problems of selection and assignment are proposed. These methods have the potential for better understanding of predictive validity of tests such as the ASVAB and improving the selection and assignment of recruits for military jobs.

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Final Report for the ONR project Psychometric Developments Related to Tests and Selection (grant awards no: N00014-93-1-0619 and N00014-95-1-0448; note that the latter grant is a continuation of the former). P.I.: Bengt Muthen, UCLA

1. Brief Overview of Scientific Work

Latent Variable Modeling of Predictive Validity

Research focused on prediction of military job performance using a latent variable model with both general ability factors and more specific factors. The papers

Gustafsson and Muthen, The nature of the general factor in hierarchical models of the structure of cognitive abilities: Alternative models tested on data from regular and experimental military enlistment tests

Muthen and Gustafsson, ASVAB-based job performance prediction and selection: Latent variable modeling versus regression analysis

describe this effort. The latter paper compares traditional regression approaches to predictive validity assessment with latent variable methods. Both papers will shortly be submitted to International Journal of Selection and Assessment.

Selection Using Latent Variable Modeling

Drawing on the types of models proposed in Muthen-Gustafsson, work has focused on methodology for selecting individuals into military jobs. Using a general-factor, specific-factor model for selection, it is shown that better job performance can be expected for selected individuals than using traditional methods for selection. The paper

Huang and Muthen, Selection and prediction using latent variable models

describes extensive artificial- and real-data analyses exemplifying this. Data are drawn from the Army Project A as well as from the Marine Corps JPM project.

Missing Data and Selectivity of Samples

Sample selectivity due to attrition is a key issue in predictive validity studies. Project work has compared existing methods for dealing with this problem with new alternatives based on both "ignorable" and "non-ignorable" missing data methods. Studies of the more realistic case of non-ignorable missingness have resulted in the paper

Liu and Muthen, Sensitivity analysis for Pearson-Lawley corrections in the context of non-ignorable missingness.

This paper has been accepted for publication in Journal of Behavioral and Educational Statistics. This paper shows that the conventional Pearson-Lawley correction is likely to produce somewhat biased estimates in many applications. The paper describes a method for using auxiliary information to inform about a likely range within which the corrected values should lie.

2. Most Exciting Accomplishments and their Significance

The most exciting accomplishment in the project is the success of latent variable modeling in using enlistment test results for predicting future job performance. Using Army Project A data and hands-on job performance as criterion, the traditional regression approach to the assessment of predictive validity of ASVAB and additional subtests has shown strong influence of the ASVAB mechanics composite, but little or no additional influence of AFQT. In contrast, the Muthen-Gustafsson latent variable approach showed that in addition to a mechanics factor, a general factor was equally important. The general factor is defined as non-verbal problem solving measured well by subtests such as the Project A reasoning test. In comparison to the regression method, the latent variable method results in higher predictive validity and higher predictive means for the criterion measure. These results have several policy implications which are important when attempting to recruit high-quality personnel for sufficient readiness in times of cutbacks. Five implications are given here.

First, the results show that the linkage equation used in the joint-services cost/performance trade-off model (McCloy et al, 1992) overemphasizes the mechanics composite of the ASVAB. This means that the linkage equation included in the joint-services software needs to be revised. Second, the individuals indicated for selection by the latent variable method have lower AFQT means than the individuals selected using the traditional regression approach. This means that use of the latent variable approach can lower the cost of recruitment. Third, the weighting of the ASVAB subtests suggested by the latent variable approach as compared to the regression approach is considerable smaller for the WK subtest of ASVAB. This means that the military may want to reconsider its current definition or use of AFQT. Fourth, the latent variable method shows that the reasoning factor is more important than the school-learning factor. This means that Project A tests which extend ASVAB need to be included in future modifications of the ASVAB so that the reasoning factor can be defined; the proposed addition of the Assembling Objects test is a good step in the right direction. Fifth, using estimated factor scores from a latent variable model with both general and specific factors enhances the selection in terms of future job performance. This means that new selection procedures based on latent variable models should be explored by the military.